

A REVIEW OF THE FOSSIL FLORA OF ALASKA, WITH DESCRIPTIONS OF NEW SPECIES.

By F. H. KNOWLTON,

Assistant Curator of the Department of Fossil Plants.

I HAVE recently had occasion, in studying a collection of leaves from Herendeen Bay and interglacial wood from beneath the Muir Glacier, to go over all of the literature relating to the fossil flora of Alaska. As the literature is somewhat widely scattered, a list of all the species of fossil plants heretofore reported from Alaska was compiled as a matter of personal interest and convenience. This was used in determining the collections above mentioned, but after completing the identifications and descriptions of new species detected it was decided to present, in connection with them, a complete compilation of the fossil flora. It was done also with the hope that it might stimulate further investigation of the paleobotany, for from what we know of the distribution of the plant-bearing beds, some of which are represented by single examples, much must remain to be accomplished. This is further shown by the fact that every collection contains a good proportion of new species.

I have first prepared an historical review of works and papers relating to the fossil flora of Alaska, which incidentally shows the geographical distribution of the plant beds. This is followed by a systematic enumeration of the fossil plants, with descriptions of the new species from Herendeen Bay, a table showing the distribution of the plants in other parts of the world, and finally a discussion of the geological age of the beds as indicated by the plants.

HISTORICAL REVIEW.

One of the first accounts of fossil plants in Alaska is given by Dr. C. Grewingk* in his classical history of the Northwest coast of America. This, however, is in the main a compilation, but the sources from which he derived his information are obscure, and I have not been able to find them. It is hardly probable that if found they would prove of much value. He reports coniferous wood from the islands of Kadiak and Unga and the Alaskan peninsula, and dicotyledons (*Alnus*) and conifers

* Beitrag zur Kennt. d. Orographischen u. Geognostischen Beschaffenheit d. Nord-West Küste Amerikas mit Anliegenden Inseln. Verhandl. d. Russ-Kais. Mineralog. Gesell. St. Petersburg. 1848-1849, St. Petersburg., 1850, pp. 41, 93, 97, 124

(*Taxodium*) from Tschugatsk (Cook Inlet) and Unalashka. He also mentions a fern from Unga which he supposed to have some resemblance to *Neuropteris acutifolia*. It is probably the same as *Osmunda Doroschkiana* of Göppert, as there is no Carboniferous known from Unga.

A year later, Grewingk again referred* to fossil plants in Alaska, especially to the fossil trunks on Unga Island, but nothing beyond this appears to have been noticed.†

In 1861 Göppert reported‡ upon a small collection of fossil plants obtained in August, 1859, by Lieut. v. Doroshin§ from the islands of Kadiak (lat. $57\frac{1}{2}^{\circ}$), Uyak|| (lat. $57\frac{1}{2}^{\circ}$), Atka¶ (lat. 52°), and Kootznahoo** (lat. $57\frac{1}{2}^{\circ}$). The last of these, Kootznahoo, is in the vicinity of or is a part of Admiralty Island, near Sitka. It afforded 2 species of dicotyledons and a single conifer. Göppert enumerated 11 species, from the combined localities, a number of which were new, but did not give descriptions of them.

In 1866 this same collection was again referred to by Göppert,†† but, unfortunately, the descriptions were not even then supplied, and consequently most of the names of new species remain *nomina nuda*.

In December, 1867, Prof. Oswald Heer, of Zurich, wrote a letter relating to Alaskan plants to Prof. A. E. Nordenskiöld, in Stockholm, which was published in the following year.‡‡ It was an enumeration of the plants brought back by Furihjelm, and may be considered as an outline of Heer's larger work which appeared in 1869. The plants are arranged according to localities and most of the new species briefly characterized.

In many respects the most important paper on the fossil plants of Alaska was Heer's *Flora Fossilis Alaskana*,§§ which was published in 1869. It was based, as stated above, upon collections brought back by Hjalmar Furihjelm, of Helsingfors, Finland, who, as governor of the

*Heidlb. Jahrb. Lit., 1851, p. 235.

†For the modern designations and orthography of Alaskan localities I am greatly indebted to Mr. Marcus Baker, of the U. S. Geological Survey.

‡Ueber d. Tertiärl. d. Polargegenden: Abhandl. d. Schles. Gesell. f. Vaterl.-Cult., 1861, Heft. II, pp., 201-204.

This paper is also published under the same title in *Mélanges Physique et Chimiques tirés du Bulletin de l'Acad. Imp. des sc. de St. Petersbourg*. Tome IV, 1860-61, St. Petersburg., 1861, pp., 695-712.

§This name is written *Doroschkin* by Göppert, but is an obvious German rendering of the Russian *Doroshin*.

||This is probably from a bay of this name on the northwest coast of Kadiak, but as there are several unnamed islands in this bay it is possible that it may be one of them.

¶This was written *Atha* by Göppert, but *Atka* is the modern spelling.

**Given as *Hudsnai* by Göppert, which is one of the earlier of the many renderings of the word *Kootznahoo*.

††Abhandl. d. Schles. Gesell. f. Vaterl.-Cult. 1865-'66. Breslau, 1867, p. 50.

‡‡Utdrag ur ett bref af Professor Oswald Heer rörande fossila växter från Nord-vestra Amerika, insamlade af Bergmästaren Hj. Furihjelm. Öfversigt af Vetenskaps-Akad. Förhandl. 1868. No. 1, pp. 63-68.

§§Kongl. Svenska Vetenskaps-Akad. Handl. Vol. VIII, No. 4, 1869, pp. 1-41, Pl. I-X.

Russian-American possessions, resided for nearly ten years in Alaska. He made, it appears, a very large collection, most of which was lost on the Mexican coast by the stranding of the ship in which they were being sent home. The specimens which finally reached Europe were obtained from the island of Kuin,* near Sitka, and from the east side of Cook Inlet, a part coming from English Bay, now better known as Port Graham (lat. $59^{\circ} 21'$; long. $151^{\circ} 52'$), and the rest from near a small stream known as the Neniltschik (lat. $60^{\circ} 9'$). The latter place is about 50 miles north of Port Graham. This paper enumerates 56 species, of which number 19 were then new to science.

In 1871 Eichwald† made a re-examination of the plants collected by Lieut. v. Doroshin that had first been studied, as above pointed out, by Göppert in 1861. Göppert, it will be remembered, did not give figures or descriptions of these plants in his paper. These were supplied by Eichwald, who also made use of Heer's *Flora Fossilis Alaskana* in working over the collection. He enumerated 9 species, 3 of which were newly named, although they had been recognized by Göppert or Heer. Eichwald also gave a list of the species reported from all parts of Alaska by Heer.

In 1882, Lesquereux published a paper entitled "Contributions to the Miocene Flora of Alaska,"‡ which was based upon material brought back by Dr. William H. Dall, then of the U. S. Coast and Geodetic Survey. The plants, which according to Lesquereux, were finely preserved, came from Coal Harbor, Unga Island; Kachemak Bay, § Cook Inlet, and Chignik Bay, Alaskan Peninsula (Lat. $56\frac{1}{2}^{\circ}$). It enumerated 21 species of which 7 were regarded as new to science. This paper was republished but without the illustrations, in Lesquereux's "Cretaceous and Tertiary Floras," 1883, pp. 257-263.

In 1882, Dr. J. S. Newberry also described new species of fossil plants from Alaska in his paper entitled "Brief Descriptions of Fossil Plants, Chiefly Tertiary, from Western North America."|| They were collected by Capt. Howard, U. S. Navy, in Cook Inlet, and Admiralty Inlet,¶ and by the U. S. S. *Saginar*, in the Kootznahoo Archipelago (Lat. $57^{\circ} 35'$, long. $134^{\circ} 19'$), the last on February 18, 1869. The figures illustrating these plants were prepared and the plates have been engraved and printed since 1871, but have not yet been formally issued. They were designed to form the illustrations of a monograph of the Hayden Geological Survey for which the text was never supplied. A posthumous work, which will embrace them, is being prepared by

* Written *Kuin* by Heer.

† Geognostisch-Paläontologische Bemerkungen Über die Halbinsel Mangischlak u. die Aleutischen Inseln. St. Petersburg, 1871, pp. 107-116, Pl. IV.

‡ Proc. U. S. Nat. Mus., vol. v, 1882 (1883), pp. 443-449, Pl. VI-X.

§ Often called Chugachik Bay and so written by Lesquereux.

|| Proc. U. S. Nat. Mus., vol. v, 1882 (1883), pp. 502-514.

¶ This is presumably an error for Admiralty Island, there being no inlet of this name in Alaska.

Dr. Newberry's successor, Dr. Arthur Hollick, of Columbia College. They are quoted in the present paper as "Plates."

In 1887, Lesquereux published a paper entitled "List of Recently Identified Fossil Plants belonging to the U. S. National Museum, with descriptions of several New Species."* This comprised a large amount of material that had been accumulating in the department of fossil plants since the founding of the Smithsonian Institution. Among them were a few species recorded as having been collected in the vicinity of Sitka, by E. W. Nelson,† and at Cape Lisburn by H. D. Woolfe. The specimens from the latter place appear to have been a part of the collection that was described from the same locality in the following year, they having been accidentally separated.

In 1888, as stated above, Lesquereux published‡ an enumeration of plants obtained at Cape Lisburn by H. D. Woolfe. This collection included 10 species of which number only one was regarded as new to science.

The last paper dealing with pre-glacial fossils is one by Felix§ in which he describes two species of silicified wood. The one obtained by Dr. Krause of Berlin on a basalt mountain south of Danaáka|| and the other from Copper Island,¶ a small island in the Southwestern part of the Bering Sea.

Mr. F. H. Herriek is the only one, so far as I now know, who has identified any of the interglacial wood. His paper, "Microscopical Examination of wood from the Buried Forest, Muir Inlet Alaska" is published as Supplement III to Harry Fielding Reid's paper "Studies of Muir Glacier, Alaska."** Mr. Herriek identified the wood submitted to him with the tide-land spruce (*Picea Sitchensis*, Carr.) now living about the glacier.

A number of pieces of wood from the buried forest Muir Glacier, obtained in 1892 by Mr. Reid, were submitted to me for examination. The report on them will be published also as an appendix to Mr. Reid's paper, soon to appear in the National Geographic Magazine. The species observed are recorded in their proper systematic position in the present paper.

The latest work dealing with fossil flora of Alaska, and this only incidentally, is the U. S. Geological Survey correlation paper on the

* Proc. U. S. Nat. Mus., Vol. x, 1887, pp. 21-46, pl. i-iv.

† I am informed by Mr. Nelson that he never visited Sitka and did not bring back any fossil plants from Alaska. This throws doubt on the specimens so recorded, and their locality, and collector remains unknown. I have retained them, however, as recorded by Lesquereux.

‡ Proc. U. S. Nat. Mus., Vol. xi, 1888, pp. 31-33, Pl. xvi, Figs. 1-6; x, Fig. 4.

§ Zeitschr. d. D. geol. Gesell. Vol. xxxviii, 1886, pp. 483-485.

|| Fifty miles north of the head of Lynn canal, in Southwestern Alaska.

¶ This is really extra-limital, but has been included as being more nearly related to the Alaskan province than to any other.

** National Geographic Magazine, Vol. iv, 1893, pp. 75-78, figs. 4, 5.

Neocene by Dr. Wm. H. Dall and G. D. Harris.* These authors review at length all fossil-bearing horizons in Alaska, and on a map accompanying the work have colored each locality geologically. They speak of plant beds in various places.

Herendeen Bay, the locality affording the specimens that form the basis of this paper, is on the northern side of the Alaskan Peninsula and forms a branch of Port Möller (Lat. $55^{\circ} 40'$, long. $160^{\circ} 40' \pm$.) The plants were collected July 28, 1890, by Mr. Charles H. Townsend, resident naturalist of the U. S. Fish Commission Steamer *Albatross*. Mr. Townsend has furnished the following copy of his notes relating to their occurrence:

July 28, 1890.—In making a tramway to the new coal mine just opened here (Herendeen Bay), one of the slaty cuttings exposed a large deposit of fossil leaves and ferns, about a mile from the beach, at the head of a little valley among the hills and within a few hundred yards of the mine itself. We visited the place twice and succeeded in getting a considerable quantity of specimens. Coal veins crop out in several places in the region of this bay. The first output of the new mine is now being used in the furnaces of the *Albatross*, but it is from near the surface and rather slaty.

Mr. Townsend further adds:

The country is mountainous and treeless, but covered with bushes and smaller vegetation. It is in general volcanic and there are lofty peaks, one of which, Pavloff, has been seen smoking.

The material in which the plants are preserved is a fine argillaceous sandstone, very well fitted for retaining the impressions. The vegetable remains are in most cases very numerous, even on small fragments of matrix.

SYSTEMATIC ENUMERATION OF SPECIES.

ALGÆ.

CHONDRITES FILICIFORMIS, Lesquereux.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. XI, 1888, p. 32, Pl. XVI, fig. 1. †
Cape Lisburn; H. D. Woolfe.

CHONDRITES HEERI, Eichwald

EICHWALD, Geognost.-Palæontolog. Bemerk. ii. Halbinsel Mangischlak und Aleutischen Inseln, St. Petersburg. 1871, p. 111, Pl. IV, fig. 1.
Chondrites sp. HEER, Fl. Foss. Alask., p. 21, Pl. X, fig. 5.

Kachemak Bay; H. Furuhielm.

The specimens at Heer's disposal were not regarded by him as of sufficient distinctness to permit of specific determination. He remarks that it appears very similar to *C. liasinus* of the Swiss Tertiary, and also resembles forms in the Trias and especially *C. Targionii* of the older Molasse. Eichwald, however, had secured better material and took the opportunity to confer Heer's name upon it. Eichwald's specimens were preserved on the same kind of dark carbonaceous shale as *Taxo-*

* Bull. U. S. Geol. Survey, No. 84, pp. 232-268, Pl. III.

† The bibliographical citations refer exclusively to the occurrence of the various species in Alaska, and are not to be regarded as indicating the synonymy.

dium *Tinajorum* and he hence regarded the species as belonging to the Miocene, suggesting that it may have been a transition form from the Cretaceous.

EQUISETACEÆ.

EQUISETUM GLOBULOSUM, Lesquereux.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 444; Cret. and Tert. Fl., p. 222, Pl. XLVIII, fig. 3.

This species was obtained by Dr. Wm. H. Dall, but the exact locality is not given. As the only localities from which he obtained fossil plants were Cook Inlet, Unga Island, and Chugachik Bay, it most probably came from one of these. It was also obtained in the Bad Lands of Dakota, from which specimens the above-mentioned figure was made.

CALAMITES AMBIGUUS, Eichwald.

EICHWALD, Geognost.-Palæontolog., Bemerk. ii. Halbinsel Mangischlak und Aleutischen Inseln, St. Petersburg, 1871, p. 114, Pl. iv, fig. 9.

Northeastern coast of Alaska north of Cape Jaklök, and south of a small stream of that name; Eichwald.

This is a small fragment only 2 inches long and 1 inch wide, showing 12 longitudinal ribs. It appears to prove, if it is really a calamite, the presence of true Carboniferous strata in Alaska, but it is so very fragmentary that I can not but look upon it with question. Göppert, who first recognized its nature, also claimed to have observed leaves of *Sigillaria*, but this, too, requires confirmation.

FILICES.

PECOPTERIS DENTICULATA, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. xi, 1888, p. 32.

Cape Lisburn; H. D. Woolfe.

PTERIS SITKENSIS, Heer.

HEER, Fl. Foss. Alask., p. 21, Pl. i, fig. 7a; EICHWALD, Geognost.-Palæontolog., Bemerk. ii. Halbinsel Mangischlak, und Aleutischen Inseln, St. Petersburg, 1871, p. 112.

Island of Kuiu, near Sitka; H. Furuhielm.

OSMUNDA DOROSCHKIANA, Göppert.

GÖPPERT, Abhandl. d. Schles. Gesell. f. Vaterländ.-Cult., 1861, Pt. II, p. 203;

EICHWALD, Geognost.-Palæontolog., Bemerk. ii. Halbinsel Mangischlak, und Aleutischen Inseln, p. 112, Pl. iv, figs. 2, 3.

Osmunda Torelli, HEER, LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 444, Pl. VI, figs. 3-6.

Unga Island; Lt. v. Doroshin. Coal Harbor, Unga Island; Dr. Wm. H. Dall.

This species was named by Göppert (l. c.) but not adequately described. It must, however, be the same as the *O. Torelli*, of Lesquereux, from the same place, since both these authors speak of the numer-

ous detached leaflets, occurring embedded in bowlders of carbonate of iron. Lesquereux describes it as follows:

"Most of the leaflets are simple, not lobate, oblong, or ovate-lanceolate entire or merely crenulate on the borders by the impressions of the veins. These leaflets are rarely preserved entire; the borders are often lacerated; they vary from 3.5 cm. to 6 cm. long and 1—2.5 cm. broad. They evidently represent leaflets from *Osmunda*."

I have ventured to restore Göppert's name, which until now has been a mere *nomen nudum*, for it is almost beyond question the plant that he gave the name to.

ASPIDIUM OERSTEDI, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. XI, 1888, p. 32.

Cape Lisburn; H. D. Woolfe.

ASPLENIUM FOERSTERI, Debey and Ettinghausen.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. XI, 1888, p. 32.

Cape Lisburn; H. D. Woolfe.

ASPLENIUM DICKSONIANUM, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. XI, 1888, p. 32.

Cape Lisburn; H. D. Woolfe.

CONIFERÆ.

PINUS! STARATSCHINI, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. XI, 1888, p. 32.

Cape Lisburn; H. D. Woolfe.

PINUS, species.

HEER, Fl. Foss. Alask., p. 23, Pl. I, fig. 11.

Port Graham; H. Furihjelrn.

SEQUOIA LANGSDORFII, (Brongniart) Heer.

HEER, Fl. Foss. Alask., p. 23, Pl. I, fig. 10.

Port Graham and Neniltschik; H. Furihjelrn. Herendeen Bay; Chas. H. Townsend.

There are a considerable number of specimens in the collection from Herendeen Bay that are referred with little hesitation to this species. They are seemingly very well preserved, but when examined closely it is found to be difficult to make out the manner of attachment of the leaves. They much resemble some of the branchlets of *Taxodium distichum miocenum* with which they are abundantly associated, but by a study of certain exceptionally well-preserved specimens it is found that

the leaves are decurrent, which clearly separates them from *Taxodium*. No cones belonging to conifers were found.

SEQUOIA SPINOSA, Newberry.

NEWBERRY, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 504; Plates, Pl. LIII. figs. 4, 5, *ined.*

Cook Inlet, Capt. Howard, U. S. Navy.

This species is described as follows, by Dr. Newberry:

"Branches slender, foliage open, rigid; leaves narrow, aente (acicular), arched upward, appressed or spreading, spirally divergent; staminate flowers in slender terminal aments 2 inches long, two lines wide, anthers few, under peltate connective scales; cones ovate or subcylindrical, composed of rhomboidal or square peltate scales."

The manuscript name on the plates above mentioned is *S. acicularis*, but this is an obvious error.

TAXODIUM DISTICHUM MIOCENUM, Heer.

HEER, Fl. Foss. Alask., p. 21, Pl. I, fig. 6; III, fig. 11c; IV, fig. 5 f. c.

Port Graham and Neniltschik; H. Furuhielm. Near Sitka; Lient. v. Doroshin. Herendeen Bay; Chas. H. Townsend.

TAXODIUM TINAJORUM, Heer.

HEER, Fl. Foss. Alask., p. 22, Pl. I, figs. 1-5.

Port Graham; H. Furuhielm.

TAXODIUM TINAJORUM, Heer; var.

EICHWALD, Geognost.-Palaeontolog. Bemerk. ii. Halbinsel Mangischlak und Aleutischen Inseln. St. Petersburg, 1871, p. 116, Pl. IV, fig. 4.

Port Graham (English Bay) and Neniltschik; Lient. H. v. Doroshin.

"The needles are 6 lines long, 1 line broad, and stand 2 lines from each other. The thickness of the leaf-bearing twig is hardly 1 line, being scarcely the width of the leaves."

This form differs from the typical form, according to Eichwald, by the smaller leaves placed at a greater distance from each other and by the well-defined midrib.

GLYPTOSTROBUS EUROPÆUS, (Brongniat) Heer.

HEER, Fl. Foss. Alask., p. 22, Pl. I, fig. 7 b-f; III, figs. 10, 11.

Knin Island, near Sitka; Lient. v. Doroshin. Neniltschik; H. Furuhielm. Herendeen Bay; Chas. H. Townsend.

TAXITES OLRIKI, Heer.

HEER, Fl. Foss. Alask., p. 23, Pl. I, fig. 8; II, 5b.

Port Graham; H. Furuhielm.

THUITES (CHAMLECYPARIS) ALASKENSIS, Lesquereux.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 445, Pl. vi, figs. 7-9.
Coal Harbor, Unga Island; Dr. Wm. H. Dall.

GINKGO MULTINERVIS, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. xi, 1888, p. 31, Pl. xvi, fig. 6.
Cape Lisburn; H. D. Woolfe.

GINKGO ADIANTOIDES, (Unger) Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. x, 1887, p. 35.
Sitka; E. W. Nelson (?).

A single small doubtful fragment from Herendeen Bay. Collected
by Chas. H. Townsend.

BAIERA PALMATA, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. xi, 1888, p. 31, Pl. xvi, figs. 4, 5.
Cape Lisburn; H. D. Woolfe.

PICEA SITCHENSIS, Carr.

HERRICK, National Geogr. Mag., Vol. iv, 1892, pp. 75-78, figs. 4, 5.—KNOWLTON,
Notes on the Examination of a Collection of Interglacial Wood from Muir
Glacier, Alaska, ms.
Muir Glacier; Harry Fielding Reid.

TSUGA MERTENSIANA, Carr.

KNOWLTON, Notes on the Examination of a Collection of Interglacial Wood
from Muir Glacier, Alaska, ms.
Muir Glacier; Harry Fielding Reid.

CUPRESSINOXYLON ERRATICUM, Mercklin.

FELIX, Zeitschr. d. D. geol., Gesell. Vol. xxxviii, 1886, p. 484.
Copper Island, southwestern part of Bering Sea; Dr. Krause.

PINITES PANNONICUS, (Unger) Göppert.

GÖPPERT, Abhandl. d. Schles. Gesell. 1861, p. 203.—HEER, Fl. Fos. Alask., p. 23.
Southwestern end of Unga Island; Lieut. v. Doroshin.

PITYOXYLON INÆQUALE, Felix.

FELIX, Zeitschr. d. D. geol., Gesell. Vol. xxxviii, 1886, p. 483, Pl. xii, fig. 3.
Basalt Mountain, south of Danaáku; Dr. Krause.

CYCADACEÆ.

ZAMITES ALASKANA, Lesquereux.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. xi, 1888, p. 32, Pl. x, fig. 10.
Cape Lisburn; H. D. Woolfe.

PODOZAMITES LATIPENNIS, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. xi, 1888, p. 31, Pl. xvi, figs. 2, 3.
Cape Lisburn; H. D. Woolfe.

GRAMINEÆ.

PIIRAGMITES ALASKANA, Heer.

HEER, Fl. Foss. Alask., p. 24, Pl. i, fig. 12.
Port Graham; H. Furuhielm.

POACITES TENUE-STRIATUS, Heer.

HEER, Fl. Foss. Alask., p. 24, Pl. i, fig. 14; EICHWALD, Geognost.-Paleontolog.
Bemerk. ii. Halbinsel Mangischlak und Aleutischen Inseln. St. Petersburg, 1871,
p. 114, Pl. iv, fig. 7.
Port Graham; H. Furuhielm. Herendeen Bay; Chas. H. Townsend.

CYPERACEÆ.

CAREX SERVATA, Heer.

HEER, Fl. Foss. Alask., p. 24, Pl. i, figs. 13, 13 c. d.
Port Graham; H. Furuhielm. Herendeen Bay; Chas. H. Townsend.

CAREX, Leaves of.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. x, 1887, p. 36.
Sitka; E. W. Nelson (?).

It is possible that this may be the *C. servata* of Heer, but as it is neither figured nor described I have retained it as probably separate.

ALISMACEÆ.

SAGITTARIA PULCHELLA, Heer.

HEER, Fl. Foss. Alask., p. 25, Pl. i, fig. 15.
Neniltschik; H. Furuhielm.

SAGITTARIA, species.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. x, 1887, p. 37.
Sitka; E. W. Nelson (?).

IRIDACEÆ.

IRITES ALASKANA, Lesquereux.

LESQUEREUX, Proc., U. S. Nat. Mus., Vol. x, 1887, p. 36.
Cape Lisburn; H. D. Woolfe.

"Leaves thickish, linear-lanceolate, tubulose at apex, narrowed to the base, falcate, æqui-nerved; median nerve obsolete; lateral nerve broad, equal.

"The leaves are comparatively narrow; the best preserved, apparently nearly entire, is 13 cm. long, 15 cm. broad in the middle; nerves

about 1 mm. in width, not very prominent, equal, not separated by intermediate veinlets, very distinct; surface smooth, covered by a thin pellicle of coaly matter, some fragments showing the tubulose point and base. The median nerve is slightly marked in places."

"Comparing these leaves with those of cultivated species of *Iris*, the essential characters, thickness of leaves, serration, etc., are the same."—[LESQUEREUX.]

SALICACEÆ.

POPULUS LATIOR. AL. Braun.

HEER, Fl. Foss. Alask., p. 25, Pl. II, fig. 4.

Port Graham; H. Furuhielm.

POPULUS GLANDULIFERA, AL. Braun.

HEER, Fl. Foss. Alask., p. 26, Pl. II, figs. 1, 2.

Port Graham; H. Furuhielm.

POPULUS BALSAMOIDES, Göppert.

HEER, Fl. Foss. Alask., p. 26, Pl. II, fig. 3.

Populus exima, GÖPPERT, Tert. fl. v. Schlossnitz, p. 23; Abhandl. Schles., Gesell., 1861, p. 203.

Port Graham; H. Furuhielm. Kutznahoo near Sitka; Lient. v. Doroshin.

POPULUS ZADDACHI, Heer.

HEER, Fl. Foss. Alask., p. 26, Pl. II, fig. 5a.

Port Graham; H. Furuhielm.

POPULUS LEUCOPHYLLA, Unger.

HEER, Fl. Foss. Alask., p. 26, Pl. II, fig. 6.

Populus acerifolia, NEWBY., Later extinct floras of North America, p. 65.

Reported by Heer, but no locality given for Alaska.

POPULUS ARCTICA, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus. Vol. v, 1882 (1883), p. 447, Pl. IX, fig. 2.

Chignik Bay; Dr. Wm. H. Dall.

POPULUS RICHARDSONI, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 441, Pl. IX, fig. 1.

Chignik Bay; Dr. Wm. H. Dall.

SALIX VARIANS, Göppert.

HEER, Fl. Foss. Alask., p. 27, Pl. II, fig. 8; III, figs. 1-3.

Salix Wimmeriana, GÖPPERT, Tert. fl. v. Schlossnitz, p. 26; Abhandl. Schles., Gesell., 1861, p. 205.

Port Graham and Neniltschik; H. Furuhielm.

SALIX MACROPHYLLA, Heer.

HEER, Fl. Foss. Alask., p. 27, Pl. II, fig. 9.—EICHWALD, Geognost.-Palæontolog. Bemerk. ü. Halbinsel Mangischlak und Aleutischen Inseln. St. Petersburg, 1871, p. 113, Pl. IV, fig. 5.

Port Graham; H. Furuhielm.

SALIX LAVATERI, Heer.

HEER, Fl. Foss. Alask., p. 27, Pl. II, fig. 10.

Port Graham; H. Furuhielm.

SALIX RÆANA, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 447, Pl. VIII, fig. 6.

Cook Inlet; Dr. Wm. H. Dall.

SALIX INTEGRÆ, Göppert.

GÖPPER, Abhandl. Schles. Gesell., 1861, p. 202; *op. cit.*, 1867, p. 50.

Neniltschik; Lieut. v. Doroshin.

SALIX MINUTA, new species.

Plate IX, fig. 1.

Leaf small, nearly circular (11 mm. long, 9 mm. wide), slightly heart-shaped at base and very slightly pointed at apex; margin entire below, with few distant teeth in the upper portion; nervation very obscure, consisting of 4-5 pairs of secondaries emerging at a low angle (40°), thence curving along the borders.

This species is founded upon the single specimen figured, and it is with much hesitation that it is described as new. The leaf appears to have been rather thick and firm as are some of the living species found in polar lands.

It is possible that it may not belong to the genus *Salix*, but as it approaches most closely to some of the forms of *S. polaris* Wahlbg.,* from the diluvial deposits of Spitzbergen, I have decided to describe it under this genus, and wait for future discoveries to prove the truth or error of this disposition. As stated above, the nervation is nearly obsolete, and all that can be made out of the 4 or 5 pairs of secondaries.

The leaf is found associated on the same piece of matrix as specimens of *Taxodium distichum miocenum*, *Paliurus Colombi*, and *Zizyphus Townsendi*.

Salix minuta was obtained at Herendeen Bay by Mr. Charles H. Townsend, of the U. S. Fish Commission steamer *Albatross*. Type, No. 3761 U. S. N. M.

CUPULIFERÆ.

FAGUS ANTIPOFII, Heer.

HEER, Fl. Foss. Alask., p. 30, Pl. v, fig. 4a; VII, figs. 4-8; VIII, fig. 1.

Port Graham; H. Furuhielm.

* Fl. Foss. Arct., Vol. II, Mioc. Fl. u. Fauna Spitzbergens, p. 90, Pl. XVI, figs. 57, 59f.

Five forms may be distinguished according to Heer, embracing *F. lancifolia*, Heer,* *F. pristina*, Sap.,† and *F. emarginata*, Heer.

FAGUS MACROPHYLLA, Unger.

HEER, Fl. Foss. Alask., p. 31, Pl. viii, fig. 2.

Port Graham; H. Furuhielm.

FAGUS FERONLÆ, Unger.

HEER, Fl. Foss. Alask., p. 31, Pl. vi, fig. 9.

Port Graham; H. Furuhielm.

FAGUS DEUCALIONIS, Unger.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 447.

Kachemak Bay, Cook Inlet; Dr. William H. Dall.

CASTANEA UNGERI, Heer.

HEER, Fl. Foss. Alask., p. 32, Pl. vii, figs. 1-3.

Port Graham; H. Furuhielm; Keku Island, Indian Archipelago?

QUERCUS PSEUDOCASTANEA, Göppert.

HEER, Fl. Foss. Alask., p. 32, Pl. vi, figs. 3-5.

Port Graham; H. Furuhielm.

QUERCUS FURUHJELMI, Heer.

HEER, Fl. Foss. Alask., p. 32, Pl. v, fig. 10; vi, figs. 1, 2.

Port Graham; H. Furuhielm.

QUERCUS PANDURATA, Heer.

HEER, Fl. Foss. Alask., p. 33, Pl. vi, fig. 6.

Port Graham; H. Furuhielm.

QUERCUS CHAMISSONIS, Heer.

HEER, Fl. Foss. Alask., p. 33, Pl. vi, figs. 7, 8.

Port Graham; H. Furuhielm.

QUERCUS DALLII, Lesquereux.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 446, Pl. viii, figs. 2-5; Cret. and Tert. Fl., p. 259.

Cook Inlet; Dr. William H. Dall.

CORYLUS MACQUARRII, (Forbes) Heer.

Plate IX, fig. 4.

HEER, Fl. Foss. Alask., p. 29, Pl. iii, fig. 9, iv, figs. 1-5, 8.—EICHWALD, Geognost.-Palæontolog. Bemerk. ü. Halbinsel Mangischlak und Alentischen Inseln, St. Petersburg, 1871, p. 113, Pl. iv, fig. 6.

Port Graham and Neniltschik; H. Furuhielm. Kuin Island near

* Heer: Öfversigt af Kongl. Vetenskaps Akad. Förhandl, 1868, p. 64.

† Saporta: Flore de Manosque; Ann. d. Sci. Nat., 1867, p. 69, Pl. vi, figs. 1-3.

Sitka; Lieut. v. Doroshin. Unga Island; Dr. William H. Dall. Herendeen Bay; Charles H. Townsend.

CORYLUS MACQUARRII var. *MACROPHYLLA*, Heer.

HEER, Fl. Foss. Alask., p. 30, Pl. iv, figs. 6, 7.

Port Graham; H. Furuhjelm.

CARPINUS GRANDIS, Unger.

HEER, Fl. Foss. Alask., p. 29, Pl. II, fig. 12.—LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 446.

Kachemak Bay, Cook Inlet; Dr. William H. Dall. Port Graham; H. Furuhjelm.

ALNUS KEFERSTEINII, (Göppert) Unger.

HEER, Fl. Foss. Alask., p. 28, Pl. III, figs. 7, 8.

Neniltschik; H. Furuhjelm.

ALNUS KEFERSTEINII, (Göppert); var.

HEER, Fl. Foss. Alask., p. 28, Pl. v, fig. 9.

Port Graham? H. Furuhjelm.

ALNUS ALASKANA, Newberry.

NEWBERRY, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 509; Plates, Pl. XLVIII, fig. 8.

Kootznahoo Archipelago, latitude $57^{\circ} 35'$, longitude $134^{\circ} 19'$; U. S. steamer *Saginaw*, Feb. 18, 1869.

"Leaf large, oblong-ovoid, acuminate, rounded or slightly heart-shaped at base; nervation crowded, 16 to 18 branches on each side of the midrib, margins set with very numerous, small, uniform, acute teeth."—[NEWBERRY.]

ALNUS GRANDIFOLIA, Newberry.

NEWBERRY, Proc., U. S. Nat. Mus., Vol. v, 1882 (1883), p. 509.

Cook Inlet; Capt. Howard, U. S. Navy.

"Leaves 4 or 5 inches in length by 3 inches in width, ovate; rounded or wedge-shaped at the base; blunt-pointed at the summit; margins coarsely dentate; nervation strong, crowded; 12 or more parallel branches on either side of the midrib, the intervals between these crossed by numerous parallel, mostly straight nervules, dividing the surface into oblong, quadrangular areoles."—[NEWBERRY.]

ALNUS CORYLIFOLIA, Lesquereux.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 446, Pl. VII, figs. 1-4; Cret. and Tert. Fl., p. 258.

Kachemak Bay, Cook Inlet; Dr. William H. Dall.

ALNUS RUBRA, Bongard.

A branch of this species found protruding from a gravel bank beneath an ice-sheet 70 feet in thickness, on the eastern moraine of

the Muir Glacier. Collected by Miss E. R. Seidmore, of Washington, D. C.

BETULA PRISCA, Etti ngshausen.

HEER, Fl. Foss. Alask., p. 28, Pl. v, figs. 3-6.

Port Graham and Neniltshik; H. Furuhjelm.

BETULA GRANDIFOLIA, Etti ngshausen.

HEER, Fl. Foss. Alask., p. 29, Pl. v, fig. 8.

Port Graham; H. Furuhjelm.

BETULA ALASKANA, Lesquereux.

LEQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 446, Pl. vi, fig. 14; Cret. and Tert. Fl., p. 258.

Chignik Bay, Alaska Peninsula; Dr. William H. Dall.

"Leaves small, round in outline, rounded or truncate at base, deeply, obtusely dentate all around except at the base, turned back or recurved on a short petiole; median nerve distinct, the lateral obsolete; catkins short cylindrical, oblong or slightly inflated in the middle.

"Except that no glands are perceivable upon the stems, this species agrees in all its characters with *Betula glandulosa* Michx. I consider it as identical."—[LESQUEREUX.]

MYRICACEÆ.

MYRICA BANKSIÆFOLIA, Unger.

HEER, Fl. Foss. Alask., p. 28, Pl. ii, fig. 11.

Port Graham; H. Furuhjelm.

The affinities of this species, according to Heer, are with *M. Californica* Cham., a species living in California.

MYRICA (COMPTONIA) CUSPIDATA, (Lesquereux) Dawson.

Comptonia cuspidata, LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 445, Pl. vi, figs. 10-12; Cret. and Tert. Fl., p. 258.

Myrica (Comptonia) cuspidata, LESQUEREUX DAWSON, Trans. Roy. Soc., Canada, 1890, p. 80, fig. 9.

Coal Harbor, Unga Island; Dr. Wm. H. Dall.

"Leaves long, linear or gradually tapering upwards to a terminal narrowly elliptical lobe, pointed or apiculate by the excurrent median nerve; pinnately lobed, lobes coriaceous, convex, subalternate, free at base, irregularly trapezoidal or oblique-oblong, inclined upwards, and sharply acute or cuspidate; primary nerves two, or three in the largest lobes, oblique, the upper curving in ascending to the acumen and branching outside, the lower parallel and curving along the borders, anastomosing with branches of the superior ones, generally separated by simple secondary, short nerves.

"Comparable to *Comptonia acutiloba* Brongt., and other European

Tertiary species of this group, but distinct from all by the large cuspidate lobes turned upwards, etc.”—[LESQUEREUX.]

MYRICA (COMPTONIA) PRÆMISSA, Lesquereux sp.

Comptonia prænmissa, LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882, p. 445, pl. vi, fig. 13.

Coal Harbor, Unga Island; Dr. Wm. H. Dall.

“Leaves long, linear in their whole length, 5–10 cm. long, 12–15 mm. broad; deeply equally pinnate-lobate; lobes very obtuse or half round, cut to the middle and slightly decurring in their point of connection, the terminal lobes very obtuse; nervation obsolete, substance somewhat thick but not coriaceous.

“This species has its greatest affinity with the living [*Myrica*] *Comptonia asplenifolia* Ait.”—[LESQUEREUX.]

MYRICA VINDOBONENSIS, (Ettingshausen) Heer.

HEER, Fl. Foss. Alask., p. 27, Pl. III, figs. 4, 5.

Neniltschik; H. Furehjelm.

JUGLANDACEÆ.

JUGLANS ACUMINATA, Al. Braun.

HEER, Fl. Foss. Alask., p. 38, Pl. IX, fig. 1.

Port Graham; H. Furehjelm.

JUGLANS NIGELLA, Heer.

HEER, Fl. Foss. Alask., p. 38, Pl. IX, figs. 2–4.

Port Graham; H. Furehjelm.

JUGLANS PICROIDES, Heer.

HEER, Fl. Foss. Alask., p. 39, Pl. IX, fig. 5.

Port Graham; H. Furehjelm.

JUGLANS WOODIANA, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 449.

Chignik Bay; Dr. Wm. H. Dall.

JUGLANS TOWNSENDI, new species.

Plate IX, Fig. 5.

Leaf thick, evidently coriaceous, oblique, margin entire; nervation prominent, consisting of a thick midrib and alternate or subopposite secondaries, those on the narrower side of the leaf emerging at a right angle, or even falling below a right angle, those on the other side

emerging at an angle of about 20° , all arching around to near the margin along which they curve until joined to the one next above, the union being affected by a series of simple loops; nervills prominent, approximately at right angle to the secondaries, except when they emerge from the midrib and join the secondary next below, producing triangular or quadrangular areas; ultimate nervation obsolete.

The fragment figured is the only one detected in the collection, and although it appears distinct, is hardly sufficient for proper characterization. It appears to differ markedly from all of the species of this genus described by Heer, from Alaska. (See above.) It is most like *J. nigella* Heer, but differs absolutely in having a perfectly entire margin. *J. acuminata* has an entire margin, but differs widely in nervation, while the remaining species, *J. pieroides*, differs in having the margin sharply serrate.

The only fossil species with which I am at present able to compare it is *J. egregia* Lx.,* from the auriferous gravels of California. It much resembles a segment taken from near the base of one of these nearly entire leaves of this species. The nervation is practically the same in both. The margin of *J. egregia* has sometimes a few small teeth, but there is no indication that such was the case in the form under discussion.

Herendeen Bay; Charles H. Townsend. Type, No. 3762, U. S. N. M.

URTICACEÆ.

FICUS ALASKANA, Newberry.

NEWBERRY, Proc. U. S. Nat. Mus. Vol. v, 1882 (1883), p. 512; Plates, Pl. LI, fig. 1; LV, figs. 1, 2.

Cook Inlet and Admiralty Inlet; Capt. Howard, U. S. Navy.

"Leaves large, reaching 8 to 10 inches in length and breadth; trilobed, generally unsymmetrical; lobes pointed, usually obtuse; margins entire or locally undulate; nervation strong, conspicuously reticulate; principal nerves three, giving off branches which divide near the margins, sometimes connecting in festoons, sometimes craspedodrome; tertiary nervation forming a coarse network of usually oblong meshes filled with fine polygonal reticulation; upper surface of the leaf smooth and polished, lower roughened by the reticulation of the nerves."—[NEWBERRY.]

FICUS MEMBRANACEA, Newberry.

NEWBERRY, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 512; Plates, Pl. LIX, fig. 2.

Cook Inlet; Capt. Howard, U. S. Navy.

"Leaves sensile, 4 to 6 inches in length by $2\frac{1}{2}$ to $3\frac{1}{2}$ in width; ovate, abruptly and usually blunt-pointed, narrowed to the base, generally unsymmetrical, margin entire, nervation delicate, open, camptodrome;

* Mem. Mus. Comp. Zool. Vol. VI., No. 2, p. 36, Pl. IX, fig. 12.

10 or more branches given off on either side of the midrib, curving upward, and forming a festoon near the margin."—[NEWBERRY.]

PLANERA UNGERI, Ettingshausen.

HEER, Fl. Foss. Alask., p. 34, Pl. v, fig. 2.
Port Graham; H. Furuhielm.

ULMUS PLURINERVIA, Unger.

HEER, Fl. Foss. Alask., p. 34, Pl. v, fig. 1.
Port Graham; H. Furuhielm.

ULMUS SORBIFOLIA, Göppert.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 447, Pl. ix, fig. 3; Cret. and Tert. Fl., p. 260.
Kachemak Bay, Cook Inlet; Dr. William H. Dall.

EBENACEÆ.

DIOSPYROS STENOSEPALA, Heer.

HEER, Fl. Foss. Alask., p. 35, Pl. viii, figs. 7, 8.
Neniltchik, H. Furuhielm.

DIOSPYROS ALASKANA, Schimper.

Diospyros Alaskana, SCHIMPER, Traité d. Pal. Vég., Vol. II, p. 945.
Diospyros lancifolia, LESQUEREUX in Heer, Fl. Foss. Alask., p. 35, Pl. iii, fig. 12.
Neniltchik, H. Furuhielm.

The name given this species by Lesquereux is preoccupied by a living species. It has consequently been changed by Schimper to *D. Alaskana*.

DIOSPYROS ANCEPS, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 448; Pl. x, figs. 1, 2; Cret. and Tert. Fl., p. 261.
Cook Inlet; Dr. William H. Dall.

OLEACEÆ.

FRAXINUS HERENDEENENSIS, new species.

Plate IX, Fig. 7.

Leaflet membranaceous (4 cm. long, 2 cm. wide), nearly regularly elliptical in outline, rounded, almost truncate at base, rapidly narrowed from above the middle to an acuminate apex; margin entire below, sparingly toothed above the middle; midrib strong; secondaries 6-8 pairs, alternate or subopposite, emerging at an angle of about 40°, camptodrome, each one joined to the one next above it by a series of regular loops just inside the margin; slender nerves from the outside

of these loops enter the teeth in the upper part; nervilles mostly percurrent, at right angles to the secondaries; finer nervation obsolete.

This species is represented by two fine leaflets, the one figured being in some respects the more perfect. They appear to have been membranaceous or possibly a little firmer. They are almost regularly elliptical in outline with a few distinct teeth above the middle. As both lack the complete base it is impossible to state anything as to the petiole or manner of attachment. They are very slightly if at all inequilateral at the base.

This species is undoubtedly closely related to *Fraxinus denticulata*, Heer,* from the Miocene of Greenland. Heer's species differ from this, however, in being clearly wedge-shaped at base, in having the margin toothed from near the base, and in having the secondaries usually opposite and at a more acute angle of divergence. It is possible that if there were a larger number of specimens of the species from Herendeen Bay they might be shown to grade more closely into *F. denticulata*, but in absence of these I have preferred to keep them separate.

Among living species the form under discussion approaches closely to some leaflets of *F. Ornus*, L., especially the terminal ones. It is also somewhat like some of the broader leaflets of *F. excelsior*, L., from northern Europe.

Herendeen Bay; Charles H. Townsend. Type, No. 3763, U. S. N. M.

ERICACEÆ.

ANDROMEDA GRAYANA, Heer

HEER, Fl. Foss., Alask., p. 34, Pl. VIII, fig. 5.

Port Graham; H. Furihjelm.

VACCINIUM FRIESII, Heer.

HEER, Fl. Foss. Alask., p. 35, Pl. VIII, fig. 4.

Port Graham; H. Furihjelm.

VACCINIUM RETICULATUM, Al. Braun.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 448, Pl. x, figs. 3-5; Cret. and Tert. Fl., p. 261.

Cook Inlet; Dr. William H. Dall.

CAPRIFOLIACEÆ.

VIBURNUM NORDENSKIÖLDI, Heer.

HEER, Fl. Foss. Alask., p. 36, Pl. III, fig. 13.

Neniltschuk; H. Furihjelm.

* Fl. Foss. Arct. Vol. I, p. 118, Pl. XVI, fig. 4.

CORNACEÆ.

NYSSA ARCTICA, ? Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v., 1882 (1883), p. 447; Cret. and Tert. Fl. p. 261.

Unga Island; Dr. William H. Dall.

CORNUS ORBIFERA, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v., 1882 (1883), p. 448, Pl. x, fig. 6; Cret. and Tert. Fl., p. 262.

Cook Inlet; Dr. William H. Dall.

ARALIACEÆ.

HEDERA AURICULATA, Heer.

HEER, Fl. Foss. Alask., p. 36, Pl. ix, fig. 6.

Port Graham; H. Furuhielm.

ONAGRACEÆ.

TRAPA BOREALIS, Heer.

HEER, Fl. Foss. Alask., p. 38, Pl. viii, figs. 9-11.

Port Graham; H. Furuhielm.

HAMAMELIDACEÆ.

LIQUIDAMBAR EUROPEUM, Al. Braun.

HEER, Fl. Foss. Alask., p. 25, Pl. ii, fig. 7.

Port Graham; H. Furuhielm.

ROSACEÆ.

SPIRÆA ANDERSONI, Heer.

HEER, Fl. Foss. Alask., p. 39, Pl. viii, fig. 3.

Port Graham; H. Furuhielm.

The affinity of this species is with the living *S. tomentosa*, L., of the Eastern United States.

PRUNUS VARIABILIS, Newberry.

NEWBERRY, Proc. U. S. Nat. Mus., Vol. v., 1882 (1883), p. 509; Plates, Pl. LII, figs. 3-5.

Cook Inlet; Capt. Howard, U. S. Navy.

"Leaves short petioléd, very variable in form; lanceolate or broadly lanceolate, 2 to 3 inches long by 1 to 2 inches wide; acuminate at the

summit, wedge shaped at base; margins thickly set with minute, acute, appressed teeth."—[NEWBERRY.]

SAPINDACEÆ.

ACER MACROPTERUM, Heer.

HEER, Fl. Foss. Alask., p. 37, Pl. IX, figs. 7-9.

Port Graham; H. Furihjelrn.

ACER TRILOBATUM PRODUCTUM, (Al. Braun) Heer.

Plate IX, fig. 3.

Herendeen Bay; Charles H. Townsend.

The single leaf figured is the only one found in the collection that can be referred to this species. It is a small leaf about 3 cm. long and 2.5 cm. wide, and agrees very closely with some of the figured European specimens referred to this form. It is, for example, especially like figs. 5 and 6 of Pl. CXIV and fig. 7 of Pl. CXV of Heer's *Fl. Tert. Helv.* These are small leaves with short lateral lobes and a prolonged central lobe. The margin is cut by sharp irregular teeth and the nervation, as nearly as can be made out, agrees perfectly with the European forms.

ANACARDIACEÆ.

RHUS FRIGIDA, new species.

Plate IX, fig. 6.

Leaflets firm, thickish, broadly lanceolate in outline, rounded, heart-shaped at base, bluntly acuminate at apex; margin sparingly toothed above the middle, teeth pointing upward; midrib distinct, straight; secondaries 7-8 pairs, alternate or subopposite, emerging at an angle of 50°, camptodrome, arching in regular bows just inside the borders, and thus joining the one next above; nervills percurrent, usually approaching a right angle to the midrib, but some also at right angles to the secondaries in the lower part of the leaflet; finer nervation obsolete.

Herendeen Bay; Charles H. Townsend. Type, No. 3764, U. S. N. M.

The leaflets of this species vary in size from 3.5 cm. to 5.25 cm. in length and from 1.25 cm. to 2 cm. in width. They are all broadly lanceolate in shape, with few teeth above the middle, and well marked camptodrome nervation.

These leaflets were at first supposed to belong to what has been described as *Fraxinus Herendeensis*, n. sp., but after careful consideration they have been separated. They differ from the above species in being much narrower, lanceolate in fact, with a heart-shaped base, and the secondaries emerging at a more acute angle. The characters of the nervation and arrangement of teeth are precisely the same in both.

A larger series (the present species is represented by three and the *Fraxinus* by only two specimens) might show them to approach more closely than now appears to be the case.

The fossil species that they approach most closely is *Rhus Meriani*, Heer,* from the Tertiary of Switzerland, from which it is almost impossible to distinguish them. The outline, shape of the base, and nervation are the same, almost the only difference being in the teeth, and even this is but slight. Ordinarily this would by no means be considered a character of sufficient weight to separate species, but unless they agree in every particular it seems to me that the antecedent probabilities are greatly in favor of plants so widely separated geographically being different. I have therefore assumed that the plant from Herendeen Bay is very closely allied to but specifically distinct from the one from Switzerland.

Among living species *Rhus frigida* is not greatly unlike some of the leaflets of *R. typhina*, L., particularly the terminal leaflets. It is also quite like some of the leaflets of *R. glabra*, L., especially a form in the National Herbarium from Deer Park, Lower Arrow Lake, British Columbia. These are slightly heart-shaped at base and have the same general outline, but the teeth are larger and more irregularly placed than in the fossil. It would seem that this form of *R. glabra* might well be the descendent of the species that inhabited arctic countries in Eocene or Miocene time.

VITACEÆ.

VITIS CRENATA, Heer.

HEER, Fl. Foss. Alask., p. 36, Pl. VIII, fig. 6.

Port Graham; H. Furuhielm.

VITIS ROTUNDIFOLIA, Newberry.

NEWBERRY, Proc. U. S. Nat. Mus., Vol. V, 1882 (1883), p. 513; Plates, Pl. LI, fig. 2; LII, fig. 3.

Admiralty Inlet; Capt. Howard, U. S. Navy.

"Leaf broadly rounded or subtriangular in outline, cordate at the base, with an acute point at the summit and at the extremity of each of the angles; intermediate portions of the margin coarsely and bluntly toothed; strongly three-nerved; tertiary nervation distinct and flexuose."—[NEWBERRY.]

CELASTRACEÆ.

ELÆODENDRON HELVETICUM, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. V, 1882 (1883), p. 449, Pl. IX, fig. 4; Cret. and Tert. Fl., p. 263.

Coal Harbor, Unga Island; Dr. William H. Dall.

* Fl. Tert. Helv. III, p. 82, Pl. CXXVI, figs. 5-11.

CELASTRUS BOREALIS, Heer.

HEER, Fl. Foss. Alask., p. 37, Pl. x, fig. 4.

Port Graham; H. Furihjelm.

ILICINEÆ.

ILEX INSIGNIS, Heer.

HEER, Fl. Foss. Alask., p. 37, Pl. x, fig. 1.

Port Graham; H. Furihjelm.

RHAMNACEÆ.

ZIZYPHUS TOWNSENDI, new species.

Pl. IX, figs. 8, 9.

Leaf thin, elliptical-lanceolate in general outline, rounded or slightly heart-shaped at base, extending above into an acuminate apex; petiole slender, 9 mm. long; margin of leaf cut into numerous sharp, usually outward-pointing teeth, which are separated by rounded sinuses; three-ribbed from the base; midrib straight, lateral ones of the same size as the midrib, equally dividing the distance between it and the margin, and, curving around, enter the apex; finer nervation obsolete.

This fine species, which I take pleasure in naming in honor of the collector, is well shown in the two figures given. The leaves appear to have been thin but firm. They are narrowly elliptical in outline, with a rather slender petiole about 1 cm. long. In size they vary from 3.5 cm. to 5 cm. in length and from 1.5 cm. to 2.2 cm. in width. They are well characterized by the teeth and the three ribs of equal size from the base. Figure 9 differs from all the others in having a very thin fourth nerve outside of the prominent ones. Unfortunately, nothing of the ultimate nervation can be made out.

This species approaches closely to the living *Zizyphus Japonica*, Thunbg., of Japan, which differs in being less regularly elliptical and in having only weak teeth.

Among fossil species this species has many that are seemingly closely related. It is, for example, very similar to *Z. serrulatus*, Ward,* from the Fort Union Group, near the mouth of the Yellowstone River, Montana, which differs in being broader, with finer, more numerous upward-pointing teeth. Prof. Ward's species also shows a tendency to be five-nerved by the addition of slender nerves outside of the more prominent ones. *Z. cinnamomoides*, Lx.,† from the Green River Group in Colorado is also similar, but differs in being wedge-shaped at base, with fewer, sharper teeth. Some of the forms of *Z. paradisica*, Ung.,‡ are quite suggestive of this species, and differ in being wedge-shaped at base, with fewer, sharper teeth. *Z. hyperboreus*, Heer,§ from the Miocene of Greenland, which might be expected in Alaska, is not particularly

* Types of the Laramie Flora, p. 73, Pl. XXXIII, figs. 3, 4.

† Tert. Fl., p. 277, Pl. LI, figs. 7, 8.

‡ Cf. Pilar, Foss. Fl. Susedana, p. 107, Pl. XIV, fig. 14.

§ Fl. Foss. Arct. VII, p. 130, Pl. LXVII, fig. 6.

close, as it differs in being much broader, with an acuminate apex and five nerves. *Z. Meekii*, Lesquereux,* from the Post-Laramie beds of Colorado has similar teeth, but differs in being much broader and in having five nerves.

The species is represented by about half a dozen specimens in a fairly good condition, except as relates to the finer nervation.

Herendeen Bay; Chas. H. Townsend, for whom it is named. Type, No. 3765, U. S. N. M.

PALIURUS COLOMBI, Heer.

Plate IX, fig. 2.

Herendeen Bay; Chas. H. Townsend.

The only specimen of this species is the one figured, which agrees closely with certain of the examples figured in the *Arctic Flora*.† The figure here referred to agrees almost exactly in size and nervation with our specimen. Fig. 4 of the same plate is also similar, being only much larger.

TILIACEÆ.

TILIA ALASKANA, Heer.

HEER, Fl. Foss. Alask., p. 36, Pl. x, figs. 2, 3.

Port Graham; H. Furuhielm.

MAGNOLIACEÆ.

MAGNOLIA NORDENSKIÖLDI, Heer.

LESQUEREUX, Proc. U. S. Nat. Mus., Vol. v, 1882 (1883), p. 448, Pl. x, figs. 7-9; Cret. and Tert. Fl., p. 262.

Chignik Bay; Dr. Wm. H. Dall.

PHYLLITES ARCTICA new species.

Plate IX, figs. 10, 11.

Leaf thickish, firm, approaching deltoid in general outline; deeply heart-shaped at base, 5- (possibly 9-) lobed, or 3-lobed, with the terminal larger lobe again 5- (possibly 7-) lobed; lower lobes at right angles to the midrib, above them being a central lobe which is provided with five (or seven) smaller lobes; margin all around provided with coarse blunt teeth; midrib straight, thick; secondaries, 4 pairs, the lower pair at right angles to the midrib or falling a little above or below a right angle; upper pairs at an angle of 45°, all entering the points of the lobes; lower pair of secondaries provided with about 5 pairs of tertiaries, which either enter or send branches to the teeth; upper secondaries sending out as many branches on the outside as there are teeth; nervills mainly percurrent, forming regular quadrangular areas between the secondaries and their branches; finer nervation mostly obsolete.

The collection contains numerous specimens of this very interesting plant, some of them being nearly perfect. The largest specimen appears

* Tert. Fl., p. 275, Pl. II, figs. 10-14.

† Fl. Foss. Arct. I, Pl. XIX, fig. 3.

to have been 10 cm. or more long and 6 or 7 cm. wide. The smaller examples appear to have been about 8 cm. in length and nearly or quite 8 cm. in width, as measured at the points of the lower lobes. As stated above, they are 7 to 9 lobed, or, with two prominent lower lobes and a central or terminal lobe, that is again provided with 5 or 7 smaller lobes. The leaves are deeply heart-shaped at base, with the lower lobes usually at right angles to the midrib, or in some cases falling below, but rarely rising above, a right angle. The upper secondaries, which all enter lobes, so far as can be made out, are at an angle of about 45° . They are opposite or subopposite. The margin all around is provided with coarse, rather blunt teeth, which are entered by the tertiaries or their branches.

I am unable at the present time to refer these leaves generically with any degree of satisfaction. They have, it is true, a vague resemblance to a considerable number of well-known genera, but when these are carefully investigated the fossil leaves are excluded from them for one cause or another. The leaf shown in fig. 11 is quite unlike the other more typical form, being less heart-shaped at base in having the lower lobes at an angle of about 20° , they being also more pointed and with smaller teeth; the general character, however, is the same.

Figure 11 is very much like *Acer trilobatum patens*, Heer, Fl. Tert. Helv., III, pl. CXXII, fig. 11, but differs in the nervation, there being no nerve running up to and forking under the principal sinuses, a well-known character in *Acer*. The teeth also differ, as also does the terminal lobe.

It has been suggested that this may represent an extreme, or anomalous form of *Corylus MacQuarrii*, a very variable species well known to be common in arctic countries, especially Alaska. The base of the larger specimen (fig. 10) does have a strong likeness to some of the forms of this species, but the lobation is much more pronounced than I have ever observed and, moreover, the borders are merely toothed and not doubly serrate as are the margins of *C. MacQuarrii*.

It has been also suggested that it may belong to *Vitis*, and it has something of a *Vitis*-like appearance, but it does not appear to me to approach close enough to any species of this genus known to me. I have therefore adopted the non-committal name of *Phyllites*, and can only express the hope that some one may be able to more satisfactorily determine it.

Herendeen Bay; Chas. H. Townsend. Type, No. 3766, U. S. N. M.

Distribution of the fossil flora of Alaska.

Species.	Distribution in Alaska.									
	Cape Lisburn.	Cape Jaklök.	Sitka, and islands near.	Admiralty Inlet. (?)	Cook Inlet.	Port Graham. Neniltschik.	Unga Island.	Chignik.	Herendeen Bay.	Muir Glacier.
<i>Chondrites filiciformis</i> , Lx	×									
<i>Chondrites Heeri</i> , Eichw.										
<i>Equisetum globulosum</i> , Lx		×								
<i>Calamites ambiguus</i> , Eichw.										
<i>Pecopteris denticulata</i> , Heer	×									
<i>Pteris Sitkensis</i> , Heer			×							
<i>Osmunda Doroschkiana</i> , Göpp.							×			
<i>Aspidium (Erstedii)</i> , Heer	×									
<i>Asplenium Foersteri</i> , Deb. and Ett.	×									
<i>Asplenium Dicksonianum</i> , Heer	×									
<i>Pinus Staratschini</i> , Heer	×									
<i>Pinus</i> sp.						×				
<i>Sequoia Langsdorffii</i> (Brongn.)					×	×			×	
<i>Sequoia spinosa</i> , Newby					×					
<i>Taxodium dist. miocenum</i> , Heer			×			×			×	
<i>Taxodium Tinajorum</i> , Heer			×			×				
<i>Taxodium Tinajorum</i> var., Eichw.										
<i>Glyptostrobus Europæus</i> , Brongniart			×			×			×	
<i>Taxites Olriki</i> , Heer						×				
<i>Thuites Alaskana</i> , Lx							×			
<i>Ginkgo multinervis</i> , Heer	×									
<i>Ginkgo adiantoides</i> , Heer			×						×	
<i>Baiera palmata</i> , (Unger) Heer	×									
<i>Picea Sitkensis</i> , Carr										×
<i>Tsuga Mertensiana</i> , Carr										×
<i>Cupressinoxylon erraticum</i> , Merck										
<i>Pinites pannonicus</i> , (Ung.), Göppert							×			
<i>Pityoxylon inaequale</i> , Felix†										
<i>Zamites Alaskana</i> , Lx	×									
<i>Podozamites latipennis</i> , Heer	×									
<i>Phragmites Alaskana</i> , Heer						×				
<i>Poaetes tenue-striatus</i> , Heer						×			×	
<i>Carex servata</i> , Heer						×			×	
<i>Carex</i> sp.			×							
<i>Sagittaria pulchella</i> , Heer						×				
<i>Sagittaria</i> sp.			×							
<i>Irites Alaskana</i> , Lx	×						×			
<i>Populus latior</i> , Al. Braun							×			
<i>Populus glandulifera</i> , Heer							×			
<i>Populus balsamoides</i> , Heer			×			×				
<i>Populus Zaddachi</i> , Heer						×				
<i>Populus leucophylla</i> , Ung.						×				
<i>Populus arctica</i> , Heer								×		
<i>Populus Richardsoni</i> , Heer								×		
<i>Salix varians</i> , Göpp.						×				
<i>Salix macrophylla</i> , Heer						×				
<i>Salix Lavateri</i> , Heer						×				
<i>Salix Beana</i> , Heer					×					
<i>Salix integra</i> , Göpp.						×				
<i>Salix minuta</i> , n. sp.									×	
<i>Fagus Autipoffii</i> , Heer						×				
<i>Fagus macrophylla</i> , Ung.						×				
<i>Fagus Feroniae</i> , Ung.						×				
<i>Fagus Dencalionis</i> , Ung.					×					
<i>Castanea Ungerii</i> , Heer			×			×				
<i>Quercus pseudocastanea</i> , Göpp.						×				
<i>Quercus Furbjelmi</i> , Heer						×				
<i>Quercus pandurata</i> , Heer						×				
<i>Quercus Chamissoni</i> , Heer						×				
<i>Quercus Dallii</i> , Lx					×					
<i>Corylus Mac Quarrii</i> , (Forbes) Heer			×			×	×		×	
<i>Corylus Mac Quarrii</i> , var. <i>macrophylla</i> , Heer						×				

* This species is extra-limital.

† This species comes from south of Danaåku, in southeastern Alaska.

Distribution of the fossil flora of Alaska—Continued.

Species.	Distribution in Alaska.								
	Cape Lisburn.	Cape Jaköb.	Sitka, and islands near.	Admiralty Inlet. (?)	Cook Inlet.	Port Graham, Nenütschik.	Unga Island.	Chignik.	Herenden Bay.
<i>Carpinus grandis</i> , Ung.					×	×			
<i>Alnus Kefersteinii</i> , (Göpp) Unger.						×			
<i>Alnus Kefersteini</i> var., Heer						×			
<i>Alnus Alaskana</i> , Lx.						×			
<i>Alnus grandifolia</i> , Newby					×				
<i>Alnus corylifolia</i> , Newby					×				
<i>Alnus rubra</i> , Bong.									×
<i>Betula prisca</i> , Ett.						×			
<i>Betula grandifolia</i> , Ett.						×			
<i>Betula Alaskana</i> , Lx.								×	
<i>Myrica banksiaefolia</i> , Ung.						×			
<i>Myrica cuspidata</i> (Lx.), Du							×		
<i>Myrica præmissa</i> (Lx.), Kn							×		
<i>Myrica vindobonensis</i> , (Ett.) Heer						×			
<i>Platanus nobilis</i> , Newby*									
<i>Juglans acuminata</i> , Al. Br.						×			
<i>Juglans nigella</i> , Heer.						×			
<i>Juglans picroides</i> , Heer						×			
<i>Juglans Woodiana</i> , Heer								×	
<i>Juglans Townsendi</i> , n. sp.									×
<i>Ficus Alaskana</i> , Newby				×	×				
<i>Ficus membranacea</i> , Newby					×				
<i>Planera Ungerii</i> , Ett						×			
<i>Ulmus plurinervia</i> , Ung						×			
<i>Ulmus sorbifolia</i> , Göppert.					×				
<i>Diospyros stenosepala</i> , Heer.						×			
<i>Diospyros Alaskana</i> , Schimper						×			
<i>Diospyros anceps</i> , Heer					×				
<i>Fraxinus Herendernensis</i> , n. sp.									×
<i>Andromeda Grayana</i> , Heer						×			
<i>Vaccinium Friesii</i> , Heer.						×			
<i>Vaccinium reticulatum</i> , Al. Br.					×				
<i>Viburnum Nordenskiöldi</i> , Heer						×			
<i>Nyssa arctica</i> ?, Heer.							×		
<i>Cornus orbifera</i> , Heer.					×				
<i>Hedera auriculata</i> , Heer.						×			
<i>Trapa borealis</i> , Heer						×			
<i>Liquidambar Europæum</i> , Al. Br.						×			
<i>Spiræa Andersoni</i> , Heer						×			
<i>Prunus variabilis</i> , Newby					×				
<i>Acer macropterum</i> , Heer						×			
<i>Acer trilobatum productum</i> , (Al. Br.) Heer									×
<i>Rhus frigida</i> , n. sp.									×
<i>Vitis crenata</i> , Heer						×			
<i>Vitis rotundifolia</i> , Newby							×		
<i>Elaeodendron Helveticum</i> , Heer.				×					
<i>Celastrus borealis</i> , Heer						×			
<i>Ilex insignis</i> , Heer						×			
<i>Zizyphus Townsendi</i> , n. sp.									×
<i>Paliurus Colombi</i> , Heer									×
<i>Tilia Alaskana</i> , Heer						×			
<i>Magnolia Nordenskiöldi</i> , Heer								×	
<i>Phyllites arctica</i> , n. sp.									×

* From Tapanica beds of Norton Sound (cf. Dall and Harris, Bull. U. S. Geol. Surv., No. 84, p. 246).

EXPLANATION OF THE TABLE.

A few words as to the manner in which the table was compiled may be of assistance in understanding its scope. I have given in the first ten columns the distribution of the fossil plants in Alaska itself. These columns also show the plants that are confined in their distribution to Alaska so far as now known. The remainder of the table is devoted to those having a distribution outside of Alaska, with the exception of those from Cape Lisburn. As those belong clearly to a much older horizon (Neocomian) about which there is little or no doubt, it has been thought unnecessary to increase the size of the table so as to show them.*

The next eight columns are devoted to the distribution of the Tertiary plants of Alaska in the United States and British Columbia. I have then selected a number of typical localities in different parts of the world at which places an abundant upper Tertiary flora is developed, such as Disco Island and Atanekerdluk, Greenland, Spitzbergen, Sachalin, Sinigalia, Ceningen, etc. The last three columns are reserved for Oligocene, Miocene, and Pliocene, when the species under discussion is not found in any of the selected typical localities, yet occurs in these horizons in other localities.

DISCUSSION OF THE TABLE.

The fossil flora of Alaska as presented in this paper embraces 115 forms. Of this number 1 is regarded as extra-limital and 3 are interglacial, being found also living about the Muir Glacier. Of the 111 forms remaining no less than 46 are peculiar to Alaska, leaving 64 forms having an outside distribution. On removing the 9 species found at Cape Lisburn about which, as pointed out above, there is little question of age, we have remaining only 55 species or a little less than 50 per cent upon which to depend for the determination of the bearing of the plants on the question of age.

An examination of the table yields the following numerical results: The Laramie has 3 species, of which 1 is doubtful; the Post Laramie beds of Colorado 10 species; the Livingston beds of Montana 6 species; the Fort Union beds 16 species, of which 1 is doubtful; the Green River Group 9 species, of which 3 are in doubt; the Mackenzie River 11 species; British Columbia has 7 species in the Miocene and 4 in the Laramie, with 2 common to both; California, represented by the auriferous gravels and allied formations, has 17 species, of which 3 are in doubt; the Eocene (Alum Bay, etc.) 6 species; the Greenland Miocene, as represented at Disco Island, Atanekerdluk, etc., has 29 species; the Miocene of Spitzbergen 20 species; the island of Sachalin (Siberia) 23 species; Sinigalia (Italy) 12 species; the so-called Baltic Miocene

*The Cape Lisburn plants will be treated by Prof. Lester F. Ward in his forthcoming paper on the correlation of the fossil plants of the Lower Cretaceous.

13 species; (Eningen 20 species; Oligocene 11 species; Miocene 33 species; Pliocene 15 species.

By combining a number of the above localities which may be legitimately taken together we have still more impressive results. Thus by the combining of the Post Laramie beds of Colorado with the Livingston beds of Montana, we have 13 species common to Alaska. The union of the Mackenzie River and Fort Union deposits gives 21 species common to Alaska, while Greenland, Spitzbergen, and Sachalin have no less than 39 species out of the 55 species from Alaska. This last result shows, if we are to place any dependence in fossil plants, that the floras of Alaska, Greenland, Spitzbergen, and the island of Sachalin are so closely related as to lead to the unavoidable conclusion that they grew under similar conditions and were synchronously deposited. The localities enumerated show that the circumpolar flora at that time was practically similar and continuous.

The coal-bearing beds of southeastern Alaska, to which Dall has given the name of the Kenai group, are perhaps best exhibited on the shores of Kachekmak Bay, Kenai Peninsula, and Cook Inlet. They appear, however, to be widely spread over British Columbia and over the coast of Alaska and its neighboring islands. According to Dall* the sequence of the rocks when undisturbed appears to be in descending order, as follows:

1. Soil and Pleistocene beds.
2. Brown Miocene sandstone, with marine shells, cetacean bones, and water-worn, teredo-bored fossil wood. (Astoria group, Nulato sandstones, Crepidula bed.)
3. Beds of conglomerate, brown and iron-stained, alternating with gravelly and sandy layers, the finer beds containing fossil leaves of Sequoia and other vegetable remains. (Kenai group, Unga beds.)
4. Bluish sandy slates and shales with a rich Miocene plant flora, interstratified with beds of indurated gravel, fossil wood, and lignitic coal. (Kenai group.)
5. Metamorphic quartzites and slaty rocks, illustrating the geologic series probably from the Jurassic to the Upper Cretaceous, with perhaps part of the Lower Eocene. (Chico-Tejon.)
6. Granite and syenite in massive beds, usually without mica and apparently in most instances forming the "backbone" of the mountain ridges or islands, but occasionally occurring in intrusive masses. (Shumagin granite.)

The geological age of these coal-bearing rocks, from which most of the plants enumerated in this paper came, has usually been regarded as Miocene. Heer, who worked up the first considerable collection of plants, referred them unhesitatingly to this horizon, and regarded them as the equivalent of the Miocene beds of Greenland, Spitzbergen, the Braunkohl of East Prussia, and the lower Molasse of Switzerland. Lesquereux and at first Newberry do not appear to have seriously questioned their Miocene age. Of the 73 species enumerated by Lesquereux in his latest publication on Alaskan plants, 21 are found in Greenland and Spitzbergen and 31 in the Miocene of other parts of the world. These considerations show, as already pointed out under

* Bull. U. S. Geol. Survey, No. 85, p. 233.

the discussion of the table, that the fossil flora of Alaska is inseparably connected with that of the Disco Island and Atanekerdhuk beds of Greenland and the so-called Arctic Miocene of Spitzbergen and Sachalin. Whatever is decided concerning them must apply with equal force to Alaska.

Mr. J. Starkie Gardner appears to have been the first to question the Miocene age of the Greenland beds,* or rather of the Arctic floras in general. The sequence of British Eocene floras is almost unbroken, and in studying them and their relations to the Miocene flora he was lead to important conclusions. He says:

There is no great break in passing from one to the other (Eocene to Miocene) when we compare them over many latitudes, and but little change beyond that brought about by altered temperature or migration. But if Tertiary floras of different ages are met with in one area, great changes on the contrary are seen, and these are mainly due to progressive modifications in climate and to altered distribution of land. Impreceptibly, too, the tropical members of the flora disappeared; that is to say, they migrated, for most of their types, I think, actually survive at the present day, many but slightly altered. Then the subtropical members decreased, and the temperate forms, never quite absent even in the Middle Eocenes, preponderated. As decreasing temperature drove the tropical forms south, the more northern must have pressed more closely upon them. The Northern Eocene, or the temperate floras of that period, must have pushed, from their home in the far north, more and more south as climates chilled, and at last, in the Miocene time, occupied our latitudes. The relative preponderance of these elements, I believe, will assist in determining the age of Tertiary deposits in Europe more than any minute comparisons of species. Thus it is useless to seek in the Arctic regions for Eocene floras, as we know them in our latitudes, for during the Tertiary period the climatic conditions of the earth did not permit their growth there. Arctic floras of temperate, and therefore Miocene, aspect are in all probability of Eocene age, and what has been recognized as a newer or Miocene facies is due to their having been first studied in Europe in latitudes which only became fitted for them in Miocene times.

This change of view as to the age of the so-called Arctic Miocene, as proposed by Gardner, has already received considerable confirmation from American paleobotanists, and while it can hardly be regarded as settled, it may be accepted as extremely probable.

Dr. J. S. Newberry, in one of his latest publications, said:†

I called the Fort Union Group Miocene because I identified it with the plant-bearing beds of Mackenzie River, Disco Island, Greenland, etc., of which the flora had been studied by Prof. Oswald Heer and was by him called Miocene. This flora, to which I shall again refer, has since been shown by Mr. J. Starkie Gardner to be Eocene. The Fort Union flora has many species in common with the Eocene beds of the Island of Mull, Bourenemonth, etc., and holds undoubtedly the same position.

On this same point Sir William Dawson says:‡

I have, also, while writing out the above notes for publication, received the paper of the same author (Gardner) on the Eocene beds of Ardtun, in Mull, and am fully confirmed thereby in the opinion derived from the papers of the Duke of Argyll and the late Prof. E. Forbes that the Mull beds very closely correspond in age with the

* British Eocene Flora, Part I, 1879, p. 8.

†Trans. N. Y. Acad. Sci. vol. ix, p. 1 of reprint.

‡Trans. Roy. Soc. Canada, 1887, p. 36.

Laramie. The *Filicites Hebridica* of Forbes is our *Onoclea sensibilis*. The species of *Ginkgo*, *Taxus*, *Sequoia*, and *Glyptostrobus* correspond, and we have now probably found a *Podocarpus*, as noted above. The *Platanites Hebridica* is very near to our great *Platanus nobilis*. *Corylus MacQuarrii* is common to both formations, as well as *Populus arctica* and *P. Richardsoni*, while many of the other exogens are generically the same, and very closely allied. These Ardtun beds are regarded by Mr. Gardner as Lower Eocene, or a little older than the Gelinden series of Saporta, and nearly of the same age with the so-called Miocene of Atanekerdluk, in Greenland. Dr. G. Dawson and the writer have, ever since 1875, maintained the Lower Eocene age of our Laramie, and of the Fort Union group of the Northwestern United States, and the identity of their flora with that of Mackenzie River and the upper beds of Greenland, and it is very satisfactory to find that Mr. Gardner has independently arrived at similar conclusions with respect to the Eocene of Great Britain.

Dr. Dall is rather more cautious in adopting the Eocene age of these beds. He says:*

I have already pointed out the probability that, if Miocene at all, the leaf beds of Greenland referred to would be synchronous with that geological epoch during which the old Miocene warm-water invertebrate fauna of the Atlantic coast penetrated as far north as New Jersey. Since that time it is highly improbable that any temperate conditions, such as the flora would indicate for the Atane period, have obtained in the latitude of Greenland. In other words, the Greenland beds are not later than the old Miocene, though this does not preclude a reference of them to an older horizon than the Miocene, for during the Eocene also the conditions in the extreme north might have been favorable to such a flora.

In Alaska, at Cooks Inlet, at Unga Island, at Sitka, and at Nulato, in the Yukon Valley, we find the leaf beds of the Kenai group immediately and conformably overlain by marine beds containing fossil shells, which are common to the Miocene of Astoria, Oregon, and to middle and southern California.

It is then certain that the Kenai leaf beds immediately preceded and their deposition terminated with the depression (probably moderate in vertical range), which enabled the marine Miocene fauna to spread over part of the antecedently dry land. Further researches along the Alaskan coast will doubtless enable us to determine whether the leaf beds themselves are underlain by marine Eocene beds or not. We know that the *Aucella* beds underlie the Kenai series, but whether there are any beds representing the marine phase of the Eocene between them is yet uncertain, though very probable.

What may be considered as reasonably certain is that the period during which in the Arctic regions the last temperate flora flourished was in a general way the same for all parts of the Arctic. It would seem highly improbable that a temperate climate should exist in the Spitzbergen and not at the same time in Greenland and Alaska, or vice versa. If Alaska was covered by the sea at this time, we should find a temperate marine fauna; if it was dry land, a temperate flora; and so with the other Arctic localities; and these indications should, it would seem, represent an identical and synchronic phase of geological history in the Arctic regions.

The distribution and character of this group have been somewhat fully discussed because, up to very recently, authorities were practically unanimous in referring it to the Miocene, a view which can yet be said to be definitely refuted. But when we consider how the Eocene Astoria bed is immediately and conformably overlain at Astoria by shales and sandstones, and that the latter conformably and immediately in like manner overlies the Kenai group, it must be conceded that the view that the latter is probably of Eocene age does not appear unreasonable.

* Bull. U. S. Geol. Survey, No. 85, p. 251.

Following out the argument suggested by Newberry and Dawson, that is, the relation existing between the plants of Alaska and Mackenzie River, and these in turn with the Canadian Laramie and the Fort Union group, we have important confirmatory evidence. The flora of the Mackenzie River beds, as worked out by Heer,* Schröter,† and Dawson,‡ now numbers 30 species, and of these no less than 12, or 40 per cent, are found in Alaska. The 12 species common to Alaska are not rare or poorly defined in the Alaskan flora, but are in the main well marked and readily determinable forms, most of which are very abundant in individuals, as for example *Sequoia Langsdorffii*, *Tarodium distichum miocenum*, *Glyptostrobus Europæus* or *Ungeri*, *Corylus MacQuarrii*, *Populus arctica*, etc. A single species, *Pteris Sitkensis*, is confined to these two localities, and a number of other species, though known by different names, are closely allied, if not identical. There can be, therefore, little doubt as to the close relationship between the Alaskan and the Mackenzie River deposits.

The Mackenzie River flora, as already suggested, is in like manner closely related with the Canadian Upper Laramie, or Fort Union group, as it is called in the United States, about 30 per cent of the Mackenzie species being common to the two.

On turning to the table we find that 16 of the 55 Alaskan species are found in the Fort Union of the United States. By combining the species common to the Mackenzie River, Canadian Upper Laramie, and Fort Union, we have 22 or 23 of these species also found in the Alaskan beds.

Without going further into the subject, which indeed the present state of our knowledge will hardly warrant, it is safe to say with Sir William Dawson that "There can scarcely be any doubt that the flora of the Upper Laramie, of the Atanekrdluk series in Greenland, and of the Spitzbergen and Alaskan Tertiaries corresponds with the Eocene of Europe, and is also identical with Fort Union flora of the Missouri region, formerly regarded as Miocene."

EXPLANATION OF PLATE IX.

- Fig. 1. *Salix minuta*, n. sp.
 Fig. 2. *Paliurus Colombi*, Heer.
 Fig. 3. *Acer trilobatum prodnetum*, (Al. Br.) Heer.
 Fig. 4. *Corylus MacQuarrii*, (Forbes) Heer.
 Fig. 5. *Juglans Townsendi*, n. sp.
 Fig. 6. *Rhus frigida*, n. sp.
 Fig. 7. *Fraxinus Herendeenensis*, n. sp.
 Figs. 8, 9. *Zizyphus Townsendi*, n. sp.
 Figs. 10, 11. *Phyllites arctica*, n. sp.

* Fl. Foss. Arct. Vol. VI. 1 Abth., 3d Nr. Beiträge zur Miocene Fl. v. Nord-Canada.

† Op. cit. Vol. VI. 1 Abth., 4th Nr. Untersuchung ii. foss. Hölzer d. Arct. zone.

‡ Trans. Roy. Soc. Canada. 1889. Fossil plants from Mackenzie and Bow rivers.